PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-217680

(43)Date of publication of application : 10.08.2001

(51)Int.Cl. H03H 9/64

H03H 9/145

(21)Application number : 2000-020779

(22)Date of filing : 28.01.2000

(71)Applicant : TOYO COMMUN EQUIP CO LTD

(72)Inventor : TAKAHASHI NAOKI

(54) LONGITUDINALLY COUPLED SURFACE ACOUSTIC WAVE FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To planarize the passing band of a filter constituted by cascading two primary-tertiary longitudinally coupled double-mode SAW filters, and to set the voltage standing wave ratio(VSWR) to less than 2.

SOLUTION: The filter is constituted, by longitudinally cascading two primary-tertiary longitudinally coupled double-mode SAW filters, composed of three IDT electrodes with electrode finger pitch L1. The pitch of the center IDT electrode of one double-mode SAW filter is set to L2, electrode fingers are removed symmetrically from both sides of the IDT electrode, and the removed electrode fingers are connected to facing IDT electrodes to form dummy electrodes with pitch L2, which is made larger than L1.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] While carrying out contiguity arrangement of the three IDT electrodes in the propagation direction of a surface wave at the principal plane top of a piezo-electric substrate In the filter which carried out 2 cascade connection of the primary 3rd [-] length joint dual mode SAW filter which arranged the grating reflector in the both sides While setting to L2 the pitch of the IDT electrode arranged in the center of one dual mode SAW filter of said filter and making it fewer than the IDT electrode which has arranged the electrode finger of this IDT electrode in the center of the dual mode SAW filter of another side The vertical joint surface acoustic wave filter which is a filter which replaced with the lessened electrode finger and has arranged the dummy electrode of a pitch Ld, and is characterized by making a pitch L2 larger than the electrode finger pitch L1 of the other IDT electrode.

[Claim 2] The vertical joint surface acoustic wave filter according to claim 1 characterized by being referred to as $1.001<L2/L1<1.015$.

[Claim 3] Claim 1 characterized by making the pitch Ld of said dummy electrode equal to L1, or a vertical joint surface acoustic wave filter given in two.

[Claim 4] Claim 1 characterized by making the pitch Ld of said dummy electrode equal to L2, or a vertical joint surface acoustic wave filter given in two.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the surface acoustic wave filter which carried out flattening of the pass band property of the cascade connection mold dual mode SAW filter which differed in the I/O impedance mutually about a surface acoustic wave filter.

[0002]

[Description of the Prior Art] In recent years, especially many surface acoustic wave filters to a cellular phone etc. are used from having the description which was used widely and was [nature / high performance, small, / mass production] excellent in the communication link field. The primary 3rd [-] length joint mold dual mode SAW filter of the former [drawing 5] While being the top view showing the configuration of the filter which carried out two-step cascade connection of (calling a dual mode SAW filter hereafter) and carrying out contiguity arrangement of the three IDT electrodes 11, 12, and 13 along the propagation direction of a surface wave on the principal plane of the piezo-electric substrate P The grating reflectors (a reflector is called hereafter) 14a and 14b are arranged in the both sides of these IDT electrodes, and the 1st dual mode SAW filter is constituted. Furthermore, while carrying out contiguity arrangement of the three IDT electrodes 15, 16, and 17 in parallel with the 1st dual mode SAW filter, Reflectors 18a and 18b are formed in these both sides, the 2nd dual mode SAW filter is constituted, cascade connection of the 2nd dual mode SAW filter is carried out to the 1st, and a concatenation mold dual mode SAW filter is constituted. The IDT electrodes 11, 12, and 13 which constitute the 1st dual mode SAW filter are constituted by the tandem type electrode of the couple which has two or more electrode fingers put mutually in between, respectively, they are the central IDT electrodes 11, while go away, connect a

form electrode to an input terminal IN, and ground the tandem type electrode of another side. Furthermore, it is the IDT electrodes 12 and 13 of both sides, while it goes away, a form electrode is connected with the input of the 1st dual mode SAW filter and the 2nd dual mode SAW filter arranged symmetrically, respectively, and the tandem type electrode of another side is grounded, respectively.

[0003] Although the 2nd dual mode SAW filter as well as [almost] the 1st dual mode SAW constitutes, the points which the logarithm of the central IDT electrode 15 was made fewer than the logarithm of the IDT electrode 11 of the 1st dual mode SAW filter, only the number of the electrode fingers which decreased formed the dummy electrodes D1 and D2 of a tandem type, went away the ground side, and have been connected to a form electrode, respectively differ. The output impedance was made by this high (for example, 200ohms) for the input impedance low (for example, 50ohms), and impedance matching with the circuit of the preceding paragraph and the latter part is realized. And all of the electrode finger pitch (a pitch is called hereafter) of the IDT electrodes 11, 12, and 13 and the IDT electrodes 15, 16, and 17 and the pitch of the dummy electrodes D1 and D2 suppose that it is the same.

[0004] Since two or more surface waves excited with the IDT electrodes 11, 12, and 13 are shut up among Reflectors 14a and 14b, and carry out the acoustic turnover of the actuation of the 1st dual mode SAW filter shown in drawing 5 as everyone knows and two vertical resonance modes, the primary order [3rd], are excited by stress with an IDT electrode pattern, it operates as a dual mode SAW filter using these two modes by giving suitable termination. In addition, the pass band width of this dual mode SAW filter of being decided by the delta frequency of primary resonance mode and the 3rd resonance mode is well known. Moreover, actuation of the 2nd dual mode SAW filter is the same as that of the 1st dual mode SAW filter. In addition, it considers as a cascade connection mold filter for making attenuation slope of a filter larger than the case of being independent, and making the inhibition zone magnitude of attenuation high as

everyone knows.

[0005] Drawing 6 (a) 881.5MHz and bandwidth for center frequency 25MHz, That the two-step concatenation mold dual mode SAW filter which set the I/O impedance to 50ohm and 200ohm, respectively should be manufactured The 39 degreeY cut X propagation LiTaO3 is used for a piezo-electric substrate. The logarithm of the central IDT electrodes 11 and 15, respectively 19.5 pairs, The logarithm of 13.5 pairs and the IDT electrodes 12, 13, 16, and 17, respectively 13.5 pairs, It is drawing having shown the filter shape at the time of setting the number of 6 and Reflectors 14a, 14b, 18a, and 18b into 200, and setting electrode layer thickness to 6.5%lambda (wavelength of an electrode period) for the dummy electrodes D1 and D2, respectively.

[0006]

[Problem(s) to be Solved by the Invention] However, like the pass band property of a filter which shows the conventional I/O impedance in drawing 6 (a) in the concatenation mold filter in which it differed, the big ripple arose in the low-pass side of a pass band, and there was a problem that a 869 to 894MHz [which is demanded as specification of RF filter of a cellular phone] passband (a slash shows) did not fulfill the specification of 3.5dB or less. Furthermore, the problem that specification or less of two was not fulfilled also had VSWR shown by hatching in said band so that the voltage standing wave ratio (VSWR) measured to drawing 6 (b) from the both sides of an input side (continuous line) and an output side (broken line) might be shown. Drawing 7 (a) and (b) are the Smith charts measured from both I/O of the above-mentioned cascade connection mold filter, near the passband, draw a big circle and are surging. It is shown that the I/O impedance of a filter is not 50 ohms of a request so that clearly from this curve. In addition, since the I/O impedance of a filter was designed with 50ohm and 200ohm, respectively, when measuring VSWR of an output side, the impedance converter (transformer) was used. Moreover, connecting an inductance to juxtaposition at a terminal impedance, and planning impedance matching as a means which makes the passband of RF filter flat, is known. Then,

it is the Smith chart which drawing 8 carried out parallel connection of the inductance 39nH by considering an input side as as [50 ohms] at the output side, and measured, and an input side to (b) measures [drawing 8 (a)] from an output side through a converter. Even if it connects an inductance to juxtaposition at an output side, it turns out that the impedance characteristic by the side of I/O does not improve. It is made in order that this invention may solve the above-mentioned problem, and while a pass band property is flat, a VSWR property aims at offering the concatenation filter which fulfilled desired specification (2 or less).

[0007]

[Means for Solving the Problem] Invention of the vertical joint surface acoustic wave filter applied to this invention in order to attain the above-mentioned object according to claim 1 While carrying out contiguity arrangement of the three IDT electrodes in the propagation direction of a surface wave at the principal plane top of a piezo-electric substrate In the filter which carried out 2 cascade connection of the primary 3rd [-] length joint dual mode SAW filter which arranged the grating reflector in the both sides While setting to L2 the pitch of the IDT electrode arranged in the center of one dual mode SAW filter of said filter and making it fewer than the IDT electrode which has arranged the electrode finger of this IDT electrode in the center of the dual mode SAW filter of another side It is the filter which replaced with the lessened electrode finger and has arranged the dummy electrode of a pitch Ld, and is the vertical joint surface acoustic wave filter characterized by making a pitch L2 larger than the electrode finger pitch L1 of the other IDT electrode. Invention according to claim 2 is a vertical joint surface acoustic wave filter according to claim 1 characterized by being referred to as $1.001<L2/L1<1.015$. Invention according to claim 3 is claim 1 characterized by making the pitch Ld of said dummy electrode equal to L1, or a vertical joint surface acoustic wave filter given in two. Invention according to claim 4 is claim 1 characterized by making the pitch Ld of said dummy electrode equal to L2, or a vertical joint surface acoustic wave filter given in two.

[0008]

[Embodiment of the Invention] This invention is explained to a detail based on the gestalt of operation shown in the drawing below. While drawing 1 differs in the I/O impedance concerning this invention mutually While being the top view showing the configuration of the cascade connection mold duplex mode filter which made the input side unbalance and made the output side the balanced circuit and carrying out contiguity arrangement of the three IDT electrodes 1, 2, and 3 along the propagation direction of a surface wave on the principal plane of a piezo-electric substrate (not shown) Reflectors 4a and 4b are arranged in the both sides of these IDT electrodes, and the 1st dual mode SAW filter is constituted. Furthermore, while carrying out contiguity arrangement of the three IDT electrodes 5, 6, and 7 in parallel with the 1st dual mode SAW filter, Reflectors 8a and 8b are formed in these both sides, the 2nd dual mode SAW filter is constituted, cascade connection of the 2nd dual mode SAW filter is carried out to the 1st, and a cascade connection mold dual mode SAW filter is constituted. The IDT electrodes 1, 2, and 3 which constitute the 1st dual mode SAW filter are constituted by the tandem type electrode of the couple which has two or more electrode fingers put mutually in between, respectively, they are the IDT electrodes 1, while go away, connect a form electrode to an input terminal IN, and ground the tandem type electrode of another side. Furthermore, it is the IDT electrodes 2 and 3, while it goes away, a form electrode is connected with the input terminal of the 2nd dual mode SAW filter, respectively, and the tandem type electrode of another side is grounded, respectively.

[0009] Although the 2nd dual mode SAW filter as well as [almost] the 1st dual mode SAW filter constitutes While considering the electrode finger of the central IDT electrode 5 as a configuration which deleted the IDT electrode 1 of the center of the 1st dual mode SAW filter from both sides to the symmetry The this eliminated electrode finger was formed as dummy electrodes D1 and D2 of a comb mold, and it is the IDT electrodes 6 and 7 of both sides, while went away, and has connected with a form electrode (in the case of drawing, it is the tandem

type electrode of the earth side). Here, each pitch of the IDT electrodes 1, 2, and 3 is set to L1, and both the pitches of L1, L2, L1, and the dummy electrodes D1 and D2 are set to Ld for the pitch of the IDT electrodes 5, 6, and 7, respectively.

[0010] The description of this invention is having made the pitch L2 of the IDT electrode 5 of the 2nd dual mode SAW filter larger than these pitches while all making equal each pitch L1 and Ld of the IDT electrodes 1, 2, and 3, the IDT electrodes 6 and 7, and the dummy electrodes D1 and D2. Moreover, while making a pitch L5 and a pitch Ld almost equal (L2**Ld), it is having made it larger than a pitch L1.

[0011] Here, the two-step concatenation mold dual mode SAW filter which set center frequency to 881.5MHz and set 25MHz and an I/O impedance to 50ohm and 200ohm for bandwidth, respectively was made as an experiment, and while making pitches L2 and Ld almost equal, it was made larger (L2/L1=1.012) than a pitch L1. The 39 degreeY cut X propagation LiTaO3 is used for a piezo-electric substrate. The logarithm of the central IDT electrodes 1 and 5, respectively 19.5 pairs, The logarithm of 13.5 pairs and the IDT electrodes 2, 3, 6, and 7, respectively 13.5 pairs, The Smith chart which measured the dummy electrodes D1 and D2 from the input side and output side of a filter at the time of setting the number of 6 and Reflectors 4a, 4b, 8a, and 8b into 200, and setting electrode layer thickness to 6.5%lambda (lambda= 2L1), respectively is shown in drawing 2 (a) and (b). In addition, parallel connection of the inductance 39nH has been carried out to the output side of a filter. It has checked that the impedance curve was rotating about 50ohms near the pass band of a filter clearly from drawing 2 R> 2 like.

[0012] Both drawing 3 (a) is filling 25MHz or more and 3.5dB or less of insertion losses of demand specification with the pass band property of the above-mentioned cascade connection mold filter. Moreover, it is clearer than drawing that drawing 3's (b)'s measured value of an input side (continuous line) and an output side (broken line) is filling two or less [of demand specification] with VSWR near the pass band. When the electrode finger pitch ratios L2/L1 took

variations, such as etching, into consideration from various experiments, it was larger than 1.001, and when it was 1.015 or less, while making the pass band property of a filter flat, it became clear that it could consider as the value of a request of VSWR.

[0013] Drawing 4 is other examples concerning this invention, and is the top views showing the configuration of the two-step cascade connection mold dual mode SAW filter which it considered [SAW filter] as the unbalanced circuit also with I/O, and changed the I/O impedance mutually. IDT electrode 5' of the center of the 2nd dual mode SAW filter, the dummy electrode D'1, and D'2 differ from drawing 1 . That is, the 2nd dual mode SAW filter went away the ground side which becomes the tandem type electrode for an output of IDT electrode 5', and a pair, and has connected this dummy electrode D'1 and D'2 to a form electrode, respectively while it is equipped with the dummy electrode D'1 and D'2 among central IDT electrode 5' and the central IDT electrodes 6 and 7 of both sides. And both the pitches of the IDT electrodes 1, 2, 3, 6, and 7 make L'd L'2, the dummy electrode D'1, and the pitch of D'2 for the pitch of IDT electrode 5' while setting them to L1 equally. The description of this example is referred to as L'2>L1 while making it into L'2**L'd. The electrode finger pitch ratio L'2 / L1 was larger than 1.001 as a result of various experiments, and when it was 1.015 or less, it turned out that a desired pass band property and VSWR are filled.

[0014] Although RF filter which uses the 39 degreeY cut X propagation LiTaO3 for a piezo-electric substrate above, and is applied to a cellular phone was explained to the example, this invention may not be limited only to this and may be applied to RF filter of other applications using piezo-electric substrates, such as lithium niobate, lithium tetraborate, and langasite.

[0015]

[Effect of the Invention] It could constitute RF filter with as small VSWR near the passband as [or less] two while the passband of a cascade connection mold dual mode SAW filter where I/O impedances differ mutually carried out flattening of it, since this invention was constituted as explained above. And since this

invention can also constitute an input-unbalance mold and an output-balanced type filter, if it is adopted as the cellular phone with which the interior of a device consists of a digital circuit and an analog circuit, the effectiveness excellent in noise reduction is expressed.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view showing the configuration of the cascade connection mold dual mode SAW filter concerning this invention.
[Drawing 2] By the Smith chart of the cascade connection mold dual mode SAW filter concerning this invention, (a) measures an input side to (b) from an output side.
[Drawing 3] (a) of the cascade connection mold dual mode SAW filter concerning this invention is a pass band property, and (b) is a VSWR property near the pass band.
[Drawing 4] It is the top view showing the configuration of the cascade connection mold dual mode SAW filter of other examples concerning this invention.

[Drawing 5] It is the top view showing the configuration of the conventional cascade connection mold dual mode SAW filter.

[Drawing 6] It is drawing in which (a) of the conventional cascade connection mold dual mode SAW filter shows a pass band property, and (b) shows the VSWR property near the pass band.

[Drawing 7] By the Smith chart of the conventional cascade connection mold dual mode SAW filter, (a) measures an input side to (b) from an output side.

[Drawing 8] By the Smith chart at the time of carrying out parallel connection of the inductance to the output side of the conventional cascade connection mold dual mode SAW filter, (a) measures an input side to (b) from an output side.

[Description of Notations]

6 1, 2, 3, 5, 5', 7 .. IDT electrode

4a, 4b, 8a, 8b .. Grating reflector

D1, D'1, D2, D'2 .. Dummy electrode

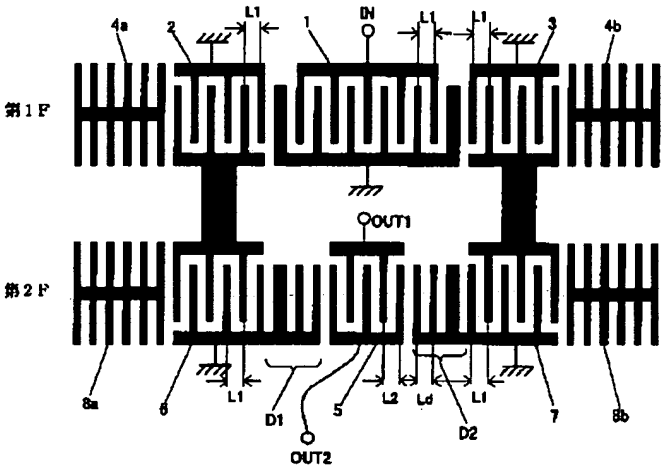
L1, L2, L'2, Ld, the electrode finger pitch of a L'd..IDT electrode

---

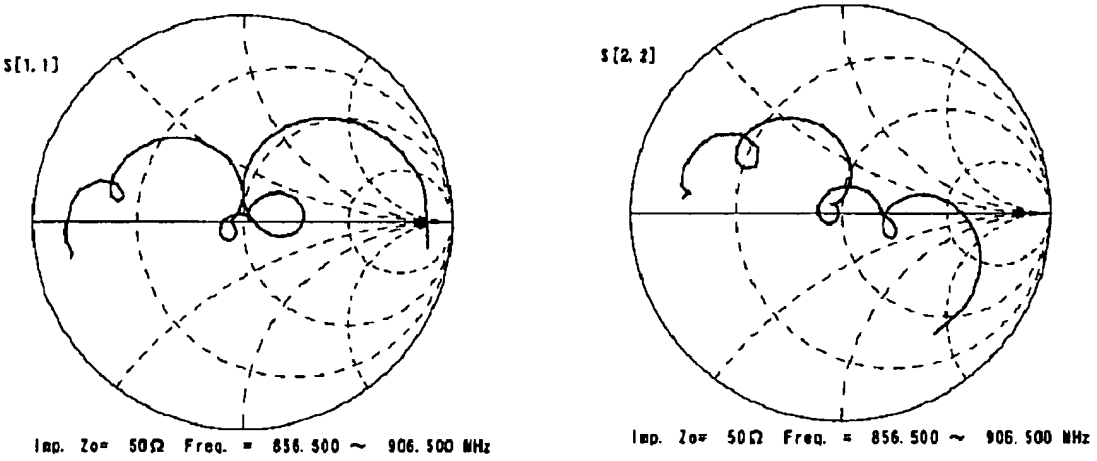
[Translation done.]

DRAWINGS

[Drawing 1]

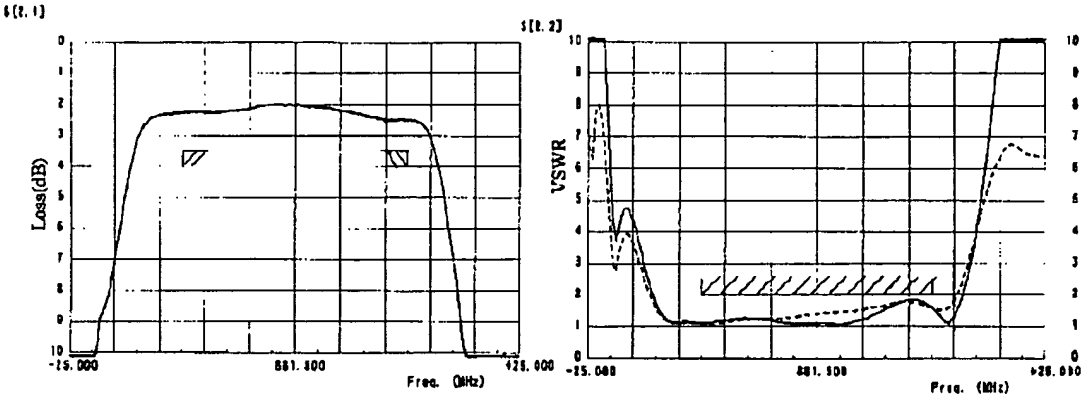


[Drawing 2]



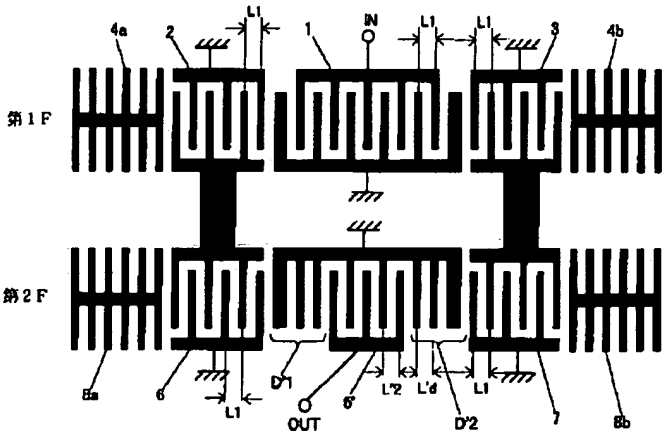
(a) (b)

[Drawing 3]

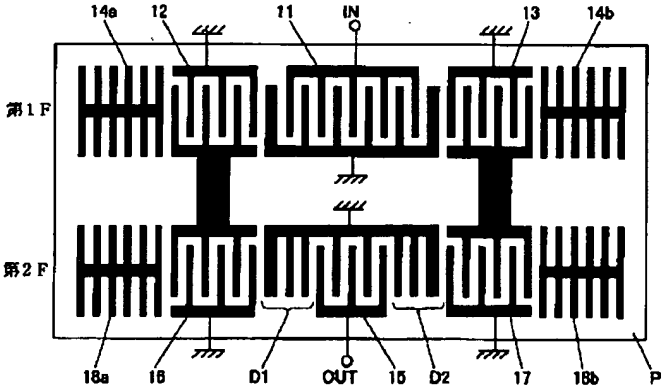


(a) (b)

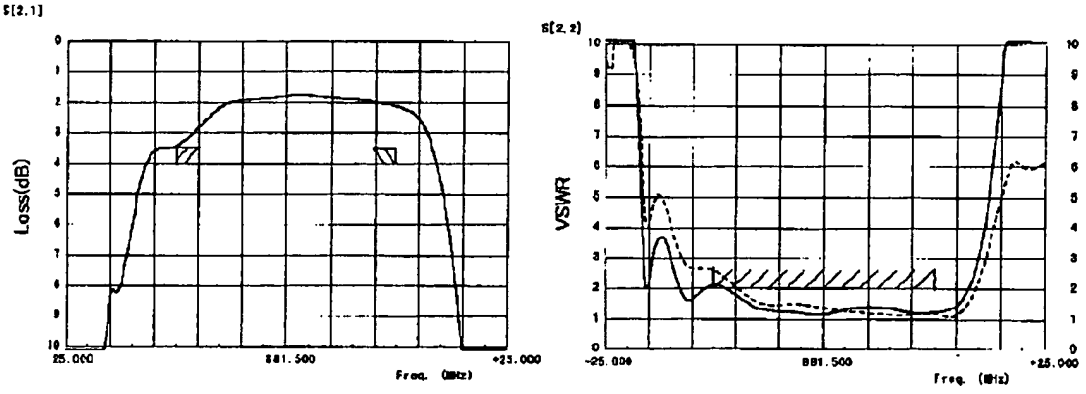
[Drawing 4]



[Drawing 5]

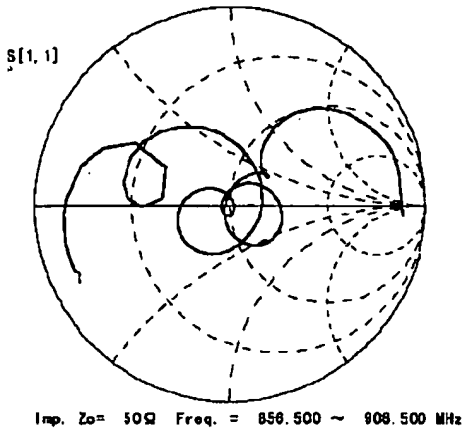


[Drawing 6]

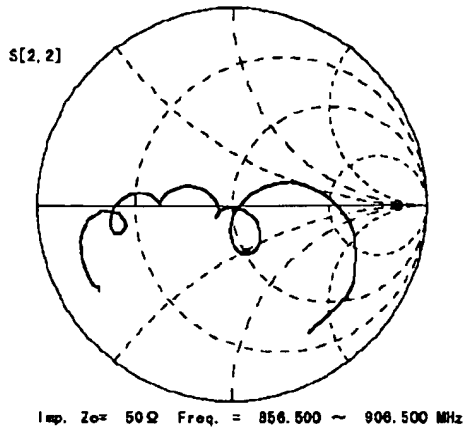


(a) (b)

[Drawing 7]

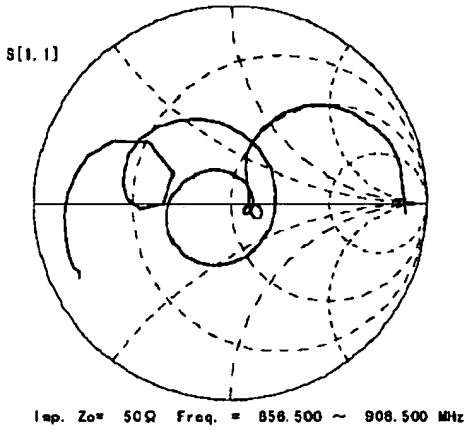


(a)

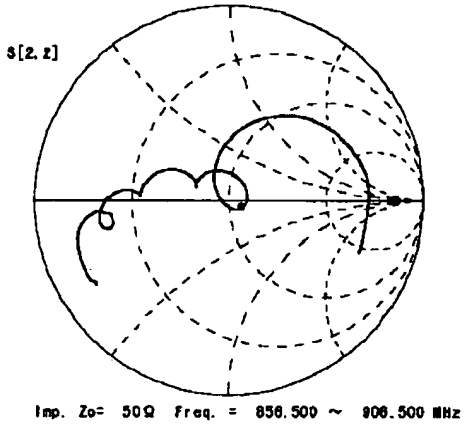


(b)

[Drawing 8]



(a)



(b)

[Translation done.]

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-217680
(43)Date of publication of application : 10.08.2001

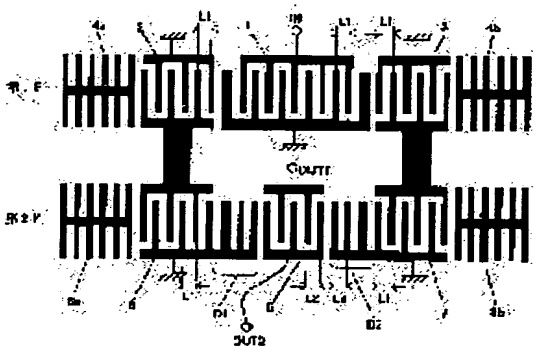
(51)Int.Cl. H03H 9/64
H03H 9/145

(21)Application number : 2000-020779
(22)Date of filing : 28.01.2000

(71)Applicant : TOYO COMMUN EQUIP CO LTD
(72)Inventor : TAKAHASHI NAOKI

(54) LONGITUDINALLY COUPLED SURFACE ACOUSTIC WAVE FILTER

(57)Abstract:
PROBLEM TO BE SOLVED: To planarize the passing band of a filter constituted by cascading two primary-tertiary longitudinally coupled double-mode SAW filters, and to set the voltage standing wave ratio (VSWR) to less than 2.
SOLUTION: The filter is constituted, by longitudinally cascading two primary-tertiary longitudinally coupled double-mode SAW filters, composed of three IDT electrodes with electrode finger pitch L1. The pitch of the center IDT electrode of one double-mode SAW filter is set to L2, electrode fingers are removed symmetrically from both sides of the IDT electrode, and the removed electrode fingers are connected to facing IDT electrodes to form dummy electrodes with pitch L2, which is made larger than L1.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

(19)日本国特許庁(JP)　(12)公開特許公報（A）　(11)特許出願公開番号

特開２００１－２１７６８０
（Ｐ２００１－２１７６８０Ａ）
(43)公開日　平成13年8月10日(2001.8.10)

(51)Int.Cl.⁷	識別記号	Ｆ Ｉ		テーマコード(参考)
Ｈ０３Ｈ 9/64		Ｈ０３Ｈ 9/64	Ｚ	5J097
9/145		9/145	Ｚ	

審査請求　未請求　請求項の数４　ＯＬ　（全７頁）

(21)出願番号　特願2000-20779(P2000-20779)

(22)出願日　平成12年1月28日(2000.1.28)

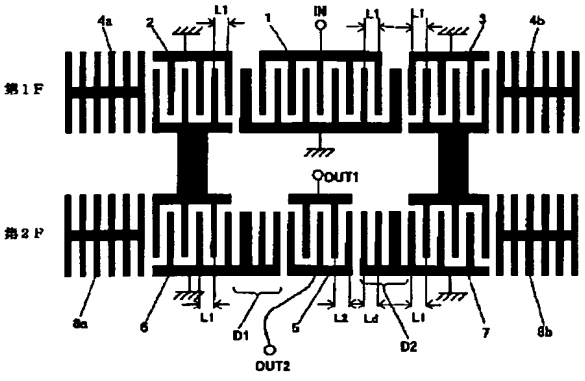
(71)出願人　000003104
東洋通信機株式会社
神奈川県高座郡寒川町小谷2丁目1番1号

(72)発明者　高橋　直樹
神奈川県高座郡寒川町小谷二丁目1番1号
東洋通信機株式会社内

Ｆターム(参考)　5J097 AA12 AA15 BB03 BB14 CC02
CC08 DD07 DD13 DD28 GG03
GG05 KK02 KK04

(54)【発明の名称】縦結合弾性表面波フィルタ

(57)【要約】
【課題】　１次－３次縦結合二重モードＳＡＷフィルタを２つ縦続接続したフィルタの通過帯域を平坦化すると共に、ＶＳＷＲを２以下と小さくする。
【解決手段】　電極指ピッチＬ１のＩＤＴ電極３個からなる１次－３次縦結合二重モードＳＡＷフィルタを２つ縦続接続したフィルタにおいて、一方の二重モードＳＡＷフィルタの中央ＩＤＴ電極のピッチをＬ２とし、該ＩＤＴ電極の両側から対称に電極指を削除すると共に、削除した電極指を対面するＩＤＴ電極に接続してピッチＬ２のダミー電極としたフィルタであり、Ｌ２をＬ１より大きくする。



1

【特許請求の範囲】

【請求項１】　圧電基板の主面上に表面波の伝搬方向に３つのＩＤＴ電極を近接配置すると共に、その両側にグレーティング反射器を配設した１次－３次縦結合二重モードＳＡＷフィルタを２つ縦続接続したフィルタにおいて、

前記フィルタの一方の二重モードＳＡＷフィルタの中央に配置するＩＤＴ電極のピッチをＬ２とし、該ＩＤＴ電極の電極指を他方の二重モードＳＡＷフィルタの中央に配置したＩＤＴ電極よりも少なくすると共に、少なくした電極指に代えてピッチＬｄのダミー電極を配置したフィルタであって、ピッチＬ２をそれ以外のＩＤＴ電極の電極指ピッチＬ１より大きくしたことを特徴とする縦結合弾性表面波フィルタ。

【請求項２】　１．００１＜Ｌ２／Ｌ１＜１．０１５としたことを特徴とする請求項１記載の縦結合弾性表面波フィルタ。

【請求項３】　前記ダミー電極のピッチＬｄをＬ１と等しくしたことを特徴とする請求項１あるいは２記載の縦結合弾性表面波フィルタ。

【請求項４】　前記ダミー電極のピッチＬｄをＬ２と等しくしたことを特徴とする請求項１あるいは２記載の縦結合弾性表面波フィルタ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は弾性表面波フィルタに関し、特に入出力インピーダンスを互いに異にした縦続接続型二重モードＳＡＷフィルタの通過域特性を平坦化した弾性表面波フィルタに関する。

【０００２】

【従来の技術】近年、弾性表面波フィルタは通信分野で広く利用され、高性能、小型、量産性等の優れた特徴を有することから特に携帯電話等に多く用いられている。図５は従来の１次－３次縦結合型二重モードＳＡＷフィルタ（以下、二重モードＳＡＷフィルタと称す）を２段縦続接続したフィルタの構成を示す平面図であって、圧電基板Ｐの主面上に表面波の伝搬方向に沿って３つのＩＤＴ電極１１、１２、１３を近接配置すると共に、これらのＩＤＴ電極の両側にグレーティング反射器（以下、反射器と称す）１４ａ、１４ｂを配設して第１の二重モードＳＡＷフィルタを構成する。さらに、第１の二重モードＳＡＷフィルタと平行して３つのＩＤＴ電極１５、１６、１７を近接配置すると共に、これらの両側に反射器１８ａ、１８ｂを設けて第２の二重モードＳＡＷフィルタを構成し、第１と第２の二重モードＳＡＷフィルタを縦続接続して縦続型二重モードＳＡＷフィルタを構成する。第１の二重モードＳＡＷフィルタを構成するＩＤＴ電極１１、１２、１３はそれぞれ互いに間挿し合う複数本の電極指を有する一対のくし形電極により構成され、中央のＩＤＴ電極１１の一方のくし形電極は入力端

2

子INに接続し、他方のくし形電極は接地する。さらに、両側のＩＤＴ電極１２、１３の一方のくし形電極は、第１の二重モードＳＡＷフィルタと対称に配置した第２の二重モードＳＡＷフィルタの入力とそれぞれ接続し、他方のくし形電極はそれぞれ接地する。

【０００３】第２の二重モードＳＡＷフィルタについても、第１の二重モードＳＡＷとほぼ同様に構成するが、中央のＩＤＴ電極１５の対数を第１の二重モードＳＡＷフィルタのＩＤＴ電極１１の対数より少なくし、少なくなった電極指の数だけくし形のダミー電極Ｄ１、Ｄ２を設けてアース側のくし形電極にそれぞれ接続している点が異なる。これにより入力インピーダンスを低く（例えば50Ω）、出力インピーダンスを高く（例えば200Ω）して前段及び後段の回路とのインピーダンス・マッチングを実現している。そして、ＩＤＴ電極１１、１２、１３及びＩＤＴ電極１５、１６、１７の電極指ピッチ（以下、ピッチと称す）および、ダミー電極Ｄ１、Ｄ２のピッチは全て同一としている。

【０００４】図５に示す第１の二重モードＳＡＷフィルタの動作は、周知のように、ＩＤＴ電極１１、１２、１３によって励起される複数の表面波が反射器１４ａ、１４ｂの間に閉じ込められて音響結合し、ＩＤＴ電極パターンにより１次と３次の２つの縦共振モードが強勢に励振されるため、適当な終端を施すことによりこれらの２つのモードを利用した二重モードＳＡＷフィルタとして動作する。なお、該二重モードＳＡＷフィルタの通過帯域幅は１次共振モードと３次共振モードとの周波数差で決まることは周知の通りである。また、第２の二重モードＳＡＷフィルタの動作は第１の二重モードＳＡＷフィルタと同様である。なお、縦続接続型フィルタとするのは、周知のように、フィルタの減衰傾度を単独の場合よりも大きくし、阻止域減衰量を高くするためである。

【０００５】図６（ａ）は、中心周波数を881.5MHz、帯域幅を25MHz、入出力インピーダンスをそれぞれ50Ω、200Ωとした２段縦続型二重モードＳＡＷフィルタを製作すべく、圧電基板に39°ＹカットＸ伝搬$LiTaO_3$を用い、中央のＩＤＴ電極１１、１５の対数をそれぞれ19.5対、13.5対、ＩＤＴ電極１２、１３、１６、１７の対数をそれぞれ13.5対、ダミー電極Ｄ１、Ｄ２をそれぞれ６本、反射器１４ａ、１４ｂ、１８ａ、１８ｂの本数をそれぞれ200本、電極膜厚を6.5％λ（電極周期の波長）とした場合のフィルタ特性を示した図である。

【０００６】

【発明が解決しようとする課題】しかしながら、従来の入出力インピーダンスを互いに異にした縦続型フィルタにおいては、図６（ａ）に示すフィルタの通過域特性のように、通過域の低域側に大きなリップルが生じて、携帯電話のＲＦフィルタの規格として要求される869MHｚから894MHｚの通過帯域（斜線で示す）が3.5ｄＢ以下という規格を満たさないという問題があった。さら

に、図６（ｂ）に入力側（実線）と出力側（破線）の双方から測定した電圧定在波比（ＶＳＷＲ）を示すように、前記帯域においてハッチングで示すＶＳＷＲが２以下という規格を満たさないという問題もあった。図７（ａ）、（ｂ）は上記縦続接続型フィルタの入出力双方から測定したスミス図表であり、通過帯域近傍で大きな円を描いてうねっている。この曲線から明らかなように、フィルタの入出力インピーダンスが所望の50Ωとなっていないことを示している。なお、フィルタの入出力インピーダンスはそれぞれ50Ωと200Ωと設計してあるので、出力側のＶＳＷＲを測定する際にはインピーダンス変換器（トランスフォーマー）を用いた。また、ＲＦフィルタの通過帯域を平坦にする手段として、終端インピーダンスに並列にインダクタンスを接続して、インピーダンス整合を図ることが知られている。そこで、図８は入力側は50Ωのままとし、出力側にインダクタンス39nHを並列接続して測定したスミス図表で、図８（ａ）が入力側から、（ｂ）が変換器を介して出力側から測定したものである。出力側に並列にインダクタンスを接続しても入出力側のインピーダンス特性は改善されていないことが分かる。本発明は上記問題を解決するためになされたものであって、通過域特性が平坦であると共に、ＶＳＷＲ特性が所望の規格（２以下）を満たした縦続フィルタを提供することを目的とする。

【０００７】

【課題を解決するための手段】上記目的を達成するために本発明に係る縦結合弾性表面波フィルタの請求項１記載の発明は、圧電基板の主面上に表面波の伝搬方向に３つのＩＤＴ電極を近接配置すると共に、その両側にグレーティング反射器を配設した１次－３次縦結合二重モードＳＡＷフィルタを２つ縦続接続したフィルタにおいて、前記フィルタの一方の二重モードＳＡＷフィルタの中央に配置するＩＤＴ電極のピッチをＬ２とし、該ＩＤＴ電極の電極指を他方の二重モードＳＡＷフィルタの中央に配置したＩＤＴ電極よりも少なくすると共に、少なくした電極指に代えてピッチＬｄのダミー電極を配置したフィルタであって、ピッチＬ２をそれ以外のＩＤＴ電極の電極指ピッチＬ１より大きくしたことを特徴とする縦結合弾性表面波フィルタである。請求項２記載の発明は、１．００１＜Ｌ２／Ｌ１＜１．０１５としたことを特徴とする請求項１記載の縦結合弾性表面波フィルタである。請求項３記載の発明は前記ダミー電極のピッチＬｄをＬ１と等しくしたことを特徴とする請求項１あるいは２記載の縦結合弾性表面波フィルタである。請求項４記載の発明は前記ダミー電極のピッチＬｄをＬ２と等しくしたことを特徴とする請求項１あるいは２記載の縦結合弾性表面波フィルタである。

【０００８】

【発明の実施の形態】以下本発明を図面に示した実施の形態に基づいて詳細に説明する。図１は本発明に係る入出力インピーダンスを互いに異にすると共に、入力側を不平衡、出力側を平衡回路とした縦続接続型二重モードフィルタの構成を示す平面図であって、圧電基板（図示しない）の主面上に表面波の伝搬方向に沿って３つのＩＤＴ電極１、２、３を近接配置すると共に、これらのＩＤＴ電極の両側に反射器４ａ、４ｂを配設して第１の二重モードＳＡＷフィルタを構成する。さらに、第１の二重モードＳＡＷフィルタと平行して３つのＩＤＴ電極５、６、７を近接配置すると共に、これらの両側に反射器８ａ、８ｂを設けて第２の二重モードＳＡＷフィルタを構成し、第１と第２の二重モードＳＡＷフィルタを縦続接続して、縦続接続型二重モードＳＡＷフィルタを構成する。第１の二重モードＳＡＷフィルタを構成するＩＤＴ電極１、２、３はそれぞれ互いに間挿し合う複数本の電極指を有する一対のくし形電極により構成され、ＩＤＴ電極１の一方のくし形電極は入力端子INに接続し、他方のくし形電極は接地する。さらに、ＩＤＴ電極２、３の一方のくし形電極はそれぞれ第２の二重モードＳＡＷフィルタの入力端子と接続し、他方のくし形電極はそれぞれ接地する。

【０００９】第２の二重モードＳＡＷフィルタについても、第１の二重モードＳＡＷフィルタとほぼ同様に構成するが、中央のＩＤＴ電極５の電極指を第１の二重モードＳＡＷフィルタの中央のＩＤＴ電極１を両側から対称に削除したような構成とすると共に、該削除した電極指をくし型のダミー電極Ｄ１、Ｄ２として形成して、両側のＩＤＴ電極６、７の一方のくし形電極（図の場合は接地側のくし形電極）に接続している。ここで、ＩＤＴ電極１、２、３のピッチをいずれもＬ１とし、ＩＤＴ電極５、６、７のピッチをそれぞれＬ１、Ｌ２、Ｌ１、ダミー電極Ｄ１、Ｄ２のピッチを共にＬｄとする。

【００１０】本発明の特徴は、ＩＤＴ電極１、２、３、ＩＤＴ電極６、７及びダミー電極Ｄ１、Ｄ２のそれぞれのピッチＬ１、Ｌｄをいずれも等しくすると共に、これらのピッチより第２の二重モードＳＡＷフィルタのＩＤＴ電極５のピッチＬ２を大きくしたことである。また、ピッチＬ５とピッチＬｄとをほぼ等しく（Ｌ２≒Ｌｄ）すると共にピッチＬ１より大きくしたことである。

【００１１】ここで、中心周波数を881.5MHz、帯域幅を25MHz、入出力インピーダンスをそれぞれ50Ω、200Ωとした２段縦続型二重モードＳＡＷフィルタを試作し、ピッチＬ２とＬｄとをほぼ等しくすると共にピッチＬ１より大きく（Ｌ２／Ｌ１＝1.012）した。圧電基板に39°ＹカットＸ伝搬$LiTaO_3$を用い、中央のＩＤＴ電極１、５の対数をそれぞれ19.5対、13.5対、ＩＤＴ電極２、３、６、７の対数をそれぞれ13.5対、ダミー電極Ｄ１、Ｄ２をそれぞれ６本、反射器４ａ、４ｂ、８ａ、８ｂの本数をそれぞれ200本、電極膜厚を6.5%λ（λ＝２Ｌ１）とした場合のフィルタの入力側と出力側から測定したスミス図表を図２（ａ）、（ｂ）に示す。なお、フィルタの

出力側にはインダクタンス39nHを並列接続してある。図２から明らかように、インピーダンス曲線はフィルタの通過域付近で50Ω近傍を回転していることが確認できた。

【００１２】図３（ａ）は上記の縦続接続型フィルタの通過域特性で要求規格の25MHz以上と、挿入損失3.5dB以下を共に満たしている。また、図３（ｂ）は通過域近傍のＶＳＷＲで入力側（実線）、出力側（破線）の測定値とも要求規格の２以下を満たしていることが図より明らかである。種々の実験から電極指ピッチ比Ｌ２／Ｌ１は、エッチング等のバラツキを考慮すると1.001より大きく、1.015以下であればフィルタの通過域特性を平坦とすると共に、ＶＳＷＲを所望の値とすることができることが判明した。

【００１３】図４は本発明に係る他の実施例で、入出力とも不平衡回路とし、入出力インピーダンスを互いに異ならせた２段縦続接続型二重モードＳＡＷフィルタの構成を示す平面図である。図１と異なるのは第２の二重モードＳＡＷフィルタの中央のＩＤＴ電極５’とダミー電極Ｄ’１、Ｄ’２である。即ち、第２の二重モードＳＡＷフィルタは中央のＩＤＴ電極５’とその両側のＩＤＴ電極６、７との間にダミー電極Ｄ’１、Ｄ’２を備えると共に、該ダミー電極Ｄ’１、Ｄ’２をＩＤＴ電極５’の出力用くし形電極と対になるアース側のくし形電極にそれぞれ接続している。そして、ＩＤＴ電極１、２、３、６、７のピッチは共に等しくＬ１とすると共に、ＩＤＴ電極５’のピッチをＬ’２、ダミー電極Ｄ’１、Ｄ’２のピッチをＬ’ｄとする。この実施例の特徴はＬ’２≒Ｌ’ｄとすると共に、Ｌ’２＞Ｌ１としたことである。種々の実験の結果電極指ピッチ比Ｌ’２／Ｌ１は1.001より大きく、1.015以下であれば所望の通過域特性、ＶＳＷＲを満たすことが分かった。

【００１４】上記では圧電基板に39°ＹカットＸ伝搬$LiTaO_3$を用いて携帯電話に適用するＲＦフィルタを例に説明したが本発明はこれのみに限定するものではなく、ニオブ酸リチウム、四硼酸リチウム、ランガサイト等の圧電基板を用いた他の用途のＲＦフィルタに適用してもよい。

【００１５】

【発明の効果】本発明は、以上説明したように構成したので、入出力インピーダンスが互いに異なる縦続接続型二重モードＳＡＷフィルタの通過帯域が平坦化すると共に、通過帯域近傍のＶＳＷＲが２以下と小さなＲＦフィルタを構成できるようになった。しかも、本発明は入力－不平衡型、出力－平衡型フィルタも構成することができるので、機器内部がデジタル回路とアナログ回路とからなる携帯電話等に採用すればノイズ低減に優れた効果を表す。

【図面の簡単な説明】

【図１】本発明に係る縦続接続型二重モードＳＡＷフィルタの構成を示す平面図である。

【図２】本発明に係る縦続接続型二重モードＳＡＷフィルタのスミス図表で、（ａ）は入力側から、（ｂ）は出力側から測定したものである。

【図３】本発明に係る縦続接続型二重モードＳＡＷフィルタの、（ａ）は通過域特性、（ｂ）は通過域近傍のＶＳＷＲ特性である。

【図４】本発明に係る他の実施例の縦続接続型二重モードＳＡＷフィルタの構成を示す平面図である。

【図５】従来の縦続接続型二重モードＳＡＷフィルタの構成を示す平面図である。

【図６】従来の縦続接続型二重モードＳＡＷフィルタの、（ａ）は通過域特性、（ｂ）は通過域近傍のＶＳＷＲ特性を示す図である。

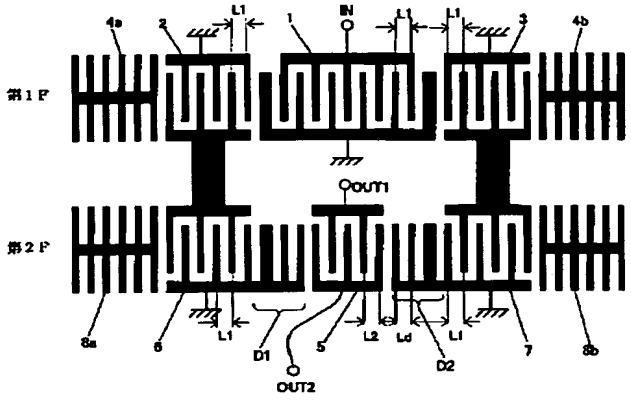
【図７】従来の縦続接続型二重モードＳＡＷフィルタのスミス図表で、（ａ）は入力側から、（ｂ）は出力側から測定したものである。

【図８】従来の縦続接続型二重モードＳＡＷフィルタの出力側にインダクタンスを並列接続した場合のスミス図表で、（ａ）は入力側から、（ｂ）は出力側から測定したものである。

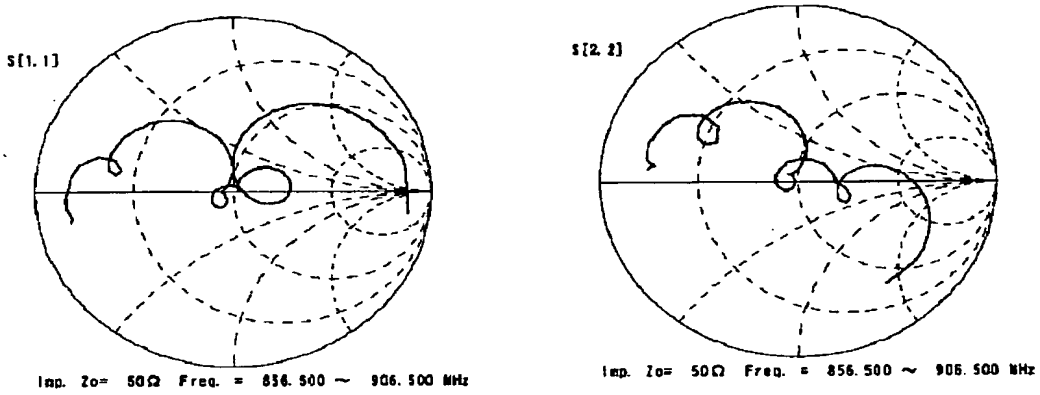
【符号の説明】

１、２、３、５、５’、６、７・・ＩＤＴ電極
４ａ、４ｂ、８ａ、８ｂ・・グレーティング反射器
Ｄ１、Ｄ’１、Ｄ２、Ｄ’２・・ダミー電極
Ｌ１、Ｌ２、Ｌ’２、Ｌｄ、Ｌ’ｄ・・ＩＤＴ電極の電極指ピッチ

【図１】

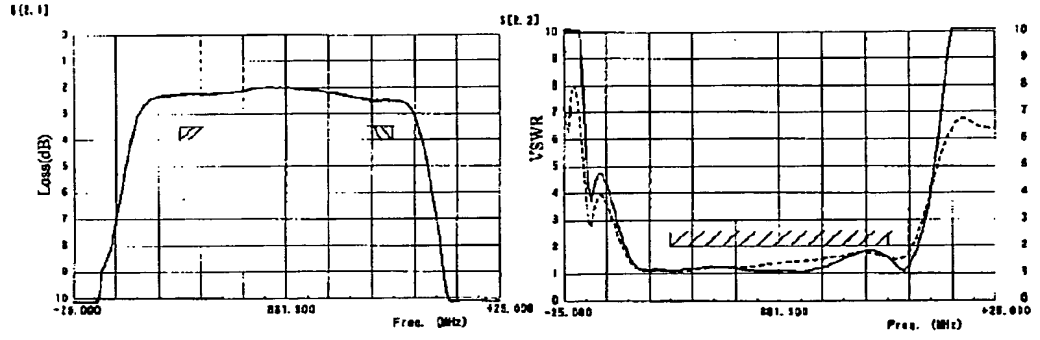

第１Ｐ
第２Ｐ
4a
2
L1
1
IN
L1
L1
3
4b
OUT1
8a
6
L1
D1
OUT2
5
L2
Ld
D2
L1
7
8b

【図２】


S[1, 1]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz
S[2, 2]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz

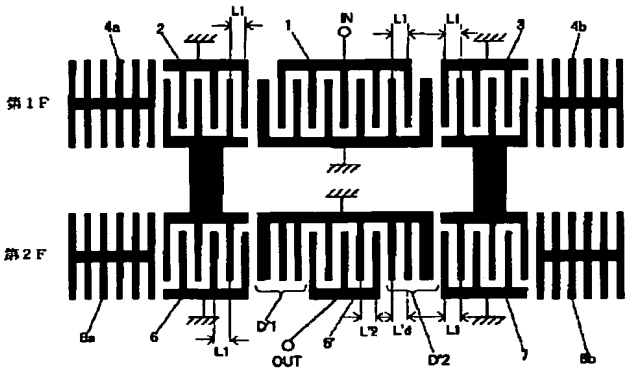
(a)　(b)

【図３】

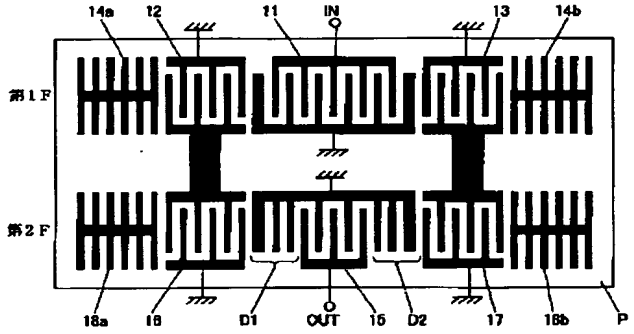

Loss(dB)
Freq. (MHz)
VSWR
Freq. (MHz)

(a)　(b)

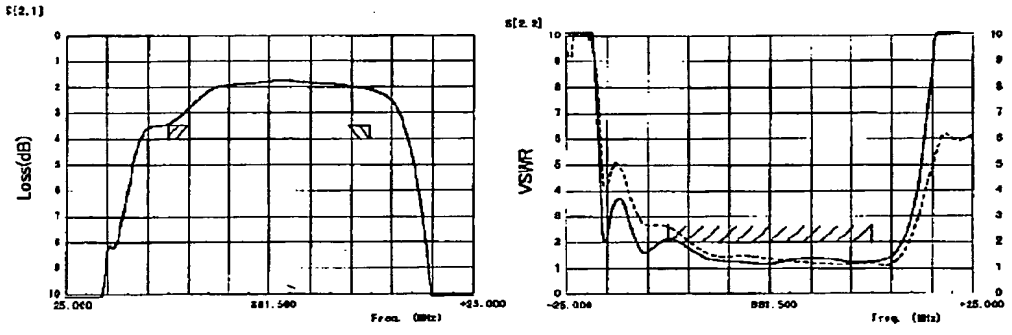
【図４】


第１Ｆ
第２Ｆ
4a
2
L1
1
IN
L1
L1
3
4b
5a
6
L1
D1
OUT
8'
L'2
L'd
L'1
D'2
7
8b

【図５】

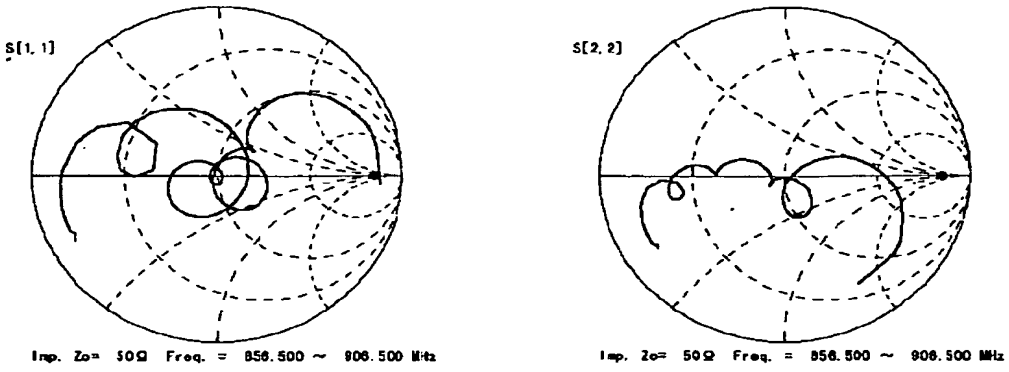

第１Ｆ
第２Ｆ
14a
12
11
IN
13
14b
18a
18
D1
OUT
16
D2
17
18b
P

【図６】


S(2,1)
Loss(dB)
25.000
881.500
+25.000
Freq. (MHz)
S(2,2)
VSWR
-25.000
881.500
+25.000
Freq. (MHz)

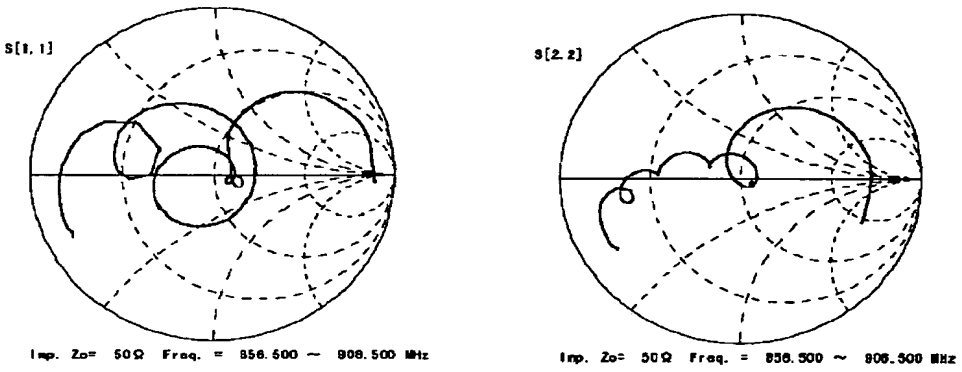
(a) (b)

【図７】


S[1, 1]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz
S[2, 2]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz

（a） （b）

【図８】


S[1, 1]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz
S[2, 2]
Imp. Zo= 50Ω Freq. = 856.500 ～ 906.500 MHz

（a） （b）